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SHEEP RESEARCH AND DEVELOPMENT - 1965

Ohio Agricultural Research and Development Center

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FOREWORD

D. S. Bell

Department of Animal Science

According to recent data published by the Statistical Reporting Service, U. S. Department of Agriculture, the meat animal product from the sheep industry in 1964 was 1,348,793,000 pounds (live weight) valued at $244.5 million dollars. The gross cash receipts amounted to $329.2 million dollars. The latter includes home consumption but does not include wool, which is a separate inventory.

Ohio ranked 11th in total sheep population in the U. S. and 12th in total lambs produced. However, Ohio ranked 24th in number of lambs saved per 100 ewes lambing. Ohio's total average lamb rearing rate of 101 percent is 9 percent higher than the national average but 24 percent below the best single state average.

For 20 years or more, the average rearing rate in Ohio and the nation has increased 10 to 15 percent. This upward trend is encouraging but, to many people, is meager in view of the general overall rise in economic level and product value. This increase scarcely seems adequate to place the sheep industry anywhere near its reproductive or meat-making potential.

The sheep industry is somewhat unique in the meat animal field as meat-making has only recently become a primary objective. Historically, from the time improved sheep were introduced into the United States in 1800-1810 until the early 1920's, wool was the primary product of the sheep industry. In Ohio, for example, nearly 8 million sheep were raised in 1865 and 92 percent of these were Merinos kept largely for their wool. As late as the 1920's, a fairly high percentage of Merino flocks in many counties were wethers kept solely for growing wool. Many ewes were bred to lamb as 3-year-olds. If a ewe didn't raise a lamb, no penalty was imposed because non-rearing ewes raised more wool of higher quality.

Crossbreeding specialized wool producing ewes to meat-type rams became a feature of the wool growing industry early in this century. This represented an effort to improve the carcass form and quality of that segment of the lamb crop destined for the meat market. The ewes most in use were inclined to produce a single lamb at birth and crossbreeding did not alter this fertility level. The average sheep rearing rate for Ohio and the nation was 75 to 85 percent.

From World War I to World War II, the sheep industry flourished. In 1932, a peak was reached of 53.1 million head for the nation. Lamb meat became an important feature of the meat market with an average consumption of slightly over 10 pounds per person. Over 33 million head of sheep and lambs passed through the nation's stockyards in 1932, most headed for conversion into meat.

During World War II, synthetic textile fibers were developed which were destined to have a profound effect upon the sheep industry of the future. One type, rayon, was made from treated cellulose and the other, nylon, was a protein-like material derivable from coal, air, and water. Both could be industrially produced and raw materials were unlimited in supply. Neither had all the remarkable properties of wool as a textile fiber but they offered price competition and replaced wool in some fabrics. The sheep industry which had operated for nearly a century and a half with wool as its principal product was suddenly cast in the role of primarily a meat-making industry.

The late Sir John Hammond, noted animal physiologist of the University of Cambridge, England, summarized the economic philosophy of the modern sheep industry in these few words: "Whether sheep pay or not depends largely on their fertility and their milk." In other words, the number of lambs born and the pounds of lamb raised per ewe are the two most important factors in determining success in the modern sheep enterprise. Reproductive function, long regarded with considerable indifference, suddenly became the most important characteristi of commercial sheep.

In this new economy, the 15 to 25 percent of the flock which had been non-rearing ewes became expensive boarders funneling off profit from producing ewes. As the general level of economic values rose throughout the country, this aspect of the sheep economy became more critical. It became economically mandatory that every ewe bear and rear at least one lamb and more if possible. Growers have been striving recently to increase the frequency of lambing so ewes would rear at least three crops of lambs each 2-year period or, if possible, to lamb twice a year.

Multiple births or an increase in the frequency of lambing have been diffic to obtain. The mechanisms that influence and the physiological processes that govern reproductive function in sheep are complex. Much research is underway, however, and the mysteries surrounding the reproductive phenomenon are becoming more clear. Likewise, the causes of loss of developing embryos and perinatal mortality are under study and becoming more clearly defined.

Some breeds or types of sheep are seasonally polyestrous. They breed large in the fall season and lamb in the late winter and early spring. Other types maintain an active estrual rhythm at all seasons when non-pregnant.

This difference between types appears to be genetic characteristic arising from long-time natural selection in the period of origin of each type. It likel is based on the ability of the progeny to survive within the prevailing environm The colder the climate in the country of type-origin, the shorter seems the peri of natural estrual rhythm. Conversely, types originating closer to the equator appear more likely to maintain a continuous polyestrual rhythm. Thus, most European breeds originating in colder climate are seasonally polyestrous and breed only in the fall. Those of Mediterranean and Asiatic origin tend to cycle continuously when not pregnant.

The Dorset breed appears to be the exception among northern European breeds as it raises both spring-born and fall-born lambs. The Dorset breed, however, possessed this characteristic in England 150 or more years ago. The English

then credited the trait largely to Merino infusion in the Dorset, the Merino being a Mediterranean type prone to year-round estrus.

Sheep also appear to be sensitive to variations in environmental light and temperature. These two factors are influencing if not controlling mechanisms in the onset of the mating cycle and perhaps in the number of fetuses developed to term. Shortening length of day and falling seasonal temperatures in late summer and fall both seem favorable to the onset of mating activity.

Sheep do not produce many monozygotic twins or two identical lambs from a single egg or ovum. Twins, triplets, or quadruplets each develop from separate fertilized eggs. Here again sheep show wide variation since some produce a single ovum at an estrual period while others may yield two, three or sometimes four eggs at an estrual period. This phenomenon is controlled by hormone secretion and balance but the differences between types of sheep undoubtedly have some genetic basis.

The fact that some types are prone to natural multiple ovulation doesn't mean that all ova will be fertilized or, if fertilized through union with a sperm cell, that all will survive. The fertility level of the ram, long thought not to play a part in fertility level manifested by the ewe, now is regarded as able to affect the number of lambs born. High environmental temperature at or closely following mating (above 90° F.) may adversely affect embryo survival. High levels of naturally occurring plant estrogens in legume pastures may delay fertilization of the egg and development of the embryo but the manner of action is not clear. Whatever happens appears to take place at or soon after mating.

These peculiarities, sensitivities, and responses of sheep contribute to wide variations in estrual activity, ovulation rate, fertility level, and rearing rate.

Sheep as a species all have many similarities but breeds or types reacting to particular environments exhibit many important differences. It is important to know about these inherent differences and their probable origin and through production records to know how each flock and each individual in the flock is responding under the given environment. Variations make it possible through selection to effect improvement within the flock.

Progeny testing is a method of establishing sire merit. This also is important because much overall flock improvement will result from use of superior sires.

Thus, in this new era where the sheep industry is primarily a meat-making industry, reproductive function which was once regarded with considerable indifference has become the most important characteristic of sheep. Reproductive physiology, the process by which each new life comes into being, and genetics, which accounts for similarities and differences between related individuals, are the two branches of biological science which will contribute most to the future of the sheep business. The use of exogenous hormones and feeding and management practices may gain some position as means of making temporary gains. Permanent improvement, however, will come about through breeding and selection.

IMPROVEMENT OF LAMB MEAT PRODUCTION THROUGH BREEDING

D. S. Bell, C. F. Parker, and L. E. Kunkle

Department of Animal Science

The long-range sheep breeding experiment being conducted cooperatively by North Dakota, Illinois, and Ohio has continued to progress since initiated in 1959.

This experiment (North Central Regional Project No. 50) is designed to develop criteria for selection in breeding to effect genetic improvement of economically important lamb-meat production traits. More specifically, the objective is to develop estimates of genetic parameters for heritability, genetic and phenotypic correlations, genetic environmental interactions, breed and strain differences, and specific gain from crossbreeding, as well as to relate carcass measurements to live lamb characteristics. From these data, it is expected that criteria for selection can be developed to effect the desired improvements.

This breeding experiment is being conducted at Fargo, North Dakota; Dixon Springs, Illinois; and Wooster, Ohio. Three breeds are involved: Targhee representing fine-wool type sheep, Columbia representing crossbred medium-wool type, and Suffolk representing English mutton type. Each station maintains two breeds. With this arrangement, each breed is maintained in two locations.

The experiment consists of four phases, any one or several of which may be in progress at any given time.

Phase I includes development of basic breeding stock under broad breed sampling and exchange of stock between two cooperating stations to establish two genetically equal breed-station groups.

Phase II includes random breeding within each breed-station group. A ram of each founding sire line (six rams or lines per group) is used on eight ewes of pure breeding. Ewes serve through not less than two reproductive seasons and then are removed as soon as a replacement is available. Each sire assigned for use within each line is used one season and then replaced. Thus, optimum generation turnover results in the maximum number of individuals producing records.

Phase III includes crossbreeding. Each of six ewe groups within each of four breed-station groups is bred to a different ram. The ram is from the opposite breed to provide opportunity for maximum hybrid vigor within F_1 lambs. Thus, data will be obtained to measure specific gain from crossbreeding.

Phase IV includes retention and breeding of F_1 ewes produced, up to a total of 48 for each breed-station group. These data should reveal any merit due to using F_1 crossbred ewes for reproduction.

In Ohio, Phase I has been completed. Phase II has been in operation for four breeding-lambing seasons. Phase III has progressed through three breeding-

lambing seasons. Phase IV has progressed to the point where F_1 ewes from each breed-station group will be put into the breeding flock in 1965. Thus, all phases of this experiment will be in operation (Phase I completed) at the Ohio station in September 1965. So the experiment is at its peak and will be for the next 5 years to develop the data required.

All data developed at the three stations are sent to the University of Illinois for uniform statistical analysis and final interpretation under the direction of Dr. H. W. Norton and the project leaders. The data can furnish little information until each phase is completed and, if prematurely interpreted, might give incorrect impressions because of its incompleteness.

Even though each phase of work must be completed before results sought in the basic objectives will be available, Ohio has been able to make some analyses in the area of ram and ewe fertility. The following article by Bell and Parker on the effect of management environment on reproductive performance was suggested by the work under North Central Regional Project No. 50. Likewise, the four studies on ram fertility reported in the article by Parker and Bell were possible as a result of extending testing procedures under NC-50.

One of the unique features of this three-state cooperative endeavor is that each station provides a different climatic environment for sheep raising. Fargo, N.D. lies essentially at 47° north latitude, Dixon Springs, Ill. at 37° north latitude, and Wooster, Ohio lies between these two. In terms of linear measurement, Fargo, N.D. is approximately 700 miles north of Dixon Springs, Ill. Wooster is essentially 400 miles south of the latitude of Fargo and 300 miles north of the latitude of Dixon Springs. For the first time known, experimental flocks that are genetically equal are being tested under two differing environments. Their performance should shed new light on adaptation of breeds, types, or crossbreds to their rearing environment.

Progress of Work and Principal Accomplishments - 1964-65

Work under this project in Ohio continued during the 1964-65 sheep year without interruption. All four breed-station groups for random breeding (Phase II) were at full strength of 48 ewes each on Sept. 1, 1964. All four breed-station groups for crossbreeding (Phase III) likewise were at full strength of 24 ewes each. Phase IV got under way when 16 F_1 yearling ewes were placed in their respective breeding lots. A total of 185 ewe lambs were developed for replacements as of July 10, 1965, when observations started on manifestation of estrus. Thus, a ewe population of 489 head, not including the 1965 ewe lambs, was carried through the year.

In addition, 52 rams, including at least 2 representatives of each of the 24 sire lines, were maintained. Fifteen vasectomized rams, required for the onset of estrus phase of this study, also were maintained.

Yield, grade, and cut-out value were obtained on 79 lambs (33 purebred and 46 crossbred) processed through the Meats Laboratory.

Heat Cycle Observations

On July 10 each year, the ewes of breeding age in all flocks are exposed for three 17-day heat-cycle periods to vasectomized rams wearing raddle marking harness. Data are recorded on ewes raddle marked during each 24-hour period. For this study, all ewes ran as a single flock with vasectomized rams assigned at the rate of 3 rams per 100 ewes until breeding began September 1.

On September 1, the vasectomized rams were transferred to the total band of ewe lambs to determine onset of estrus and cycling performance of 7- to 8-month-old ewe lambs. This period of observation covered three 17-day cycling periods up to October 22, a total of 51 days. The total group includes random bred lambs bred pure and F_1 crossbred females. Eventually, the total heat cycle activity of all ewes at all ages both as purebreds and as crossbred types should be available.

In 1964, a total of 294 1- to 4-year-old Columbia and Targhee ewes in the four breed-station groups were exposed to vasectomized rams wearing raddle marking harness for three 17-day periods beginning July 10 and ending August 31. The results are summarized in Table 1.

Table 1. - Percent of ewes manifesting first estrus by 17-day periods, 1964

Breed	Columbia		Targhee	
Station of Origin	Ohio	N.Dakota	Ohio	Illinois
No. Ewes Assigned	69	65	85	75
Percent Showing First Estrus:				
July 10 - July 27	17.4	4.6	23.5	26.7
July 28 - Aug. 13	37.7	29.7	45.9	50.7
Aug. 14 - Aug. 31	37.7	40.0	17.6	13.3
After Aug. 31	7.3	26.2	12.9	9.3
Av. Date of First Estrus	Aug. 15	Aug. 22	Aug. 10	Aug. 6
Earliest Date of First Estrus	July 16	July 18	July 15	July 15
Latest Date of First Estrus	Oct. 11	Oct. 2	Sept. 23	Sept. 23

In this observation of estrual activity, several breed and breed-station group differences appear. A higher percentage of ewes of the Targhee breed exhibited their first estrual activity earlier than Columbia ewes. By August 13, 69.4 percent of the Ohio Targhee ewes and 77.3 percent of the Illinois Targhee ewes had manifested first estrus and 55.1 percent of the Ohio Columbia ewes and 34.3 percent of the North Dakota Columbia ewes had exhibited first estrus. However, the date on which the first ewe of each breed-station group exhibited

estrus was essentially the same.

Individual variation as to the first ewe and the last ewe to show estrus was 60 days in each of the two Targhee groups and 87 and 76 days for the two Columbia groups. If onset of estrus is a photoperiodic phenomenon, ewes must vary widely in their sensitivity to the light stimulus.

It has long been believed that ewes tend to manifest estrus as length of day shortens and as nights become cooler. With an official weather station within a half mile of the Ohio sheep unit where these records were obtained, it was possible to summarize maximum, minimum and average daily temperatures by periods of testing and to compare the average for the 1964 periods with the 77-year average for the same period. This Ohio weather station also measures solar and sky radiation (measured as gm. calories/cm^2/day). This average for periods of testing is also included in the following table.

Table 2. Weather report (Wooster 1964) for periods of checking estrual activity

Period	Av. Temperature (degrees F.) Average Maximum	Average Minimum	Mean Av.	77-Year Mean Av.	Average of Solar & Sky Radiation gm. cal./cm^2/day
July 1 - July 10	80.2	57.0	68.6	70.98	568.7
July 10 - July 27	84.7	60.8	72.8	71.81	560.1
July 28 - Aug. 13	78.9	56.2	67.5	71.6	503.4
Aug. 14 - Aug. 31	77.5	54.3	65.9	68.7	493.3
Sept. 1 - Sept.17	78.5	47.9	63.2	66.1	461.8

On the basis of the data in Tables 1 and 2, it is difficult to find any relationship between estrual activity and the recorded weather data. The first estrual activity (July 10-July 27) occurred in the period of the highest maximum, minimum, and mean average daily temperature.

This record will be useful mainly for defining prevailing weather during periods when the records were obtained and for defining the general environment under which the sheep were raised.

Manifestation of Estrus by 1964-Born Ewe Lambs

On September 1, vasectomized rams wearing raddle marking harness were turned with 185 ewe lambs at the rate of 4 rams per 100 females. The objective was to

obtain a record of estrual activity between September 1 and November 13 or essentially over four 17-day periods. These lambs, most of which were born during the last week of January or in early February, represented four breed-station groups and four crossbred groups.

A total of 110 of the 185 ewe lambs showed at least one raddle marking during the 68-day exposure period, indicating that 59.4 percent of the lambs manifested estrus. Only 37 lambs (20 percent) manifested two or more estrual periods in a cyclic manner. Only 6 lambs of the 185 (3.2 percent) manifested three estrual periods in a cyclic manner.

September 18 through October 23 was the period of greatest activity. The breed-station groups bred pure varied in the percentage of ewe lambs showing estrus. All crossbred groups were nearly identical to the highest of the breed-station groups bred pure.

Although not shown in the table, it was evident that neither age of lamb nor body weight as recorded in this test could be taken as an indication that the lamb would exhibit estrus.

Breeding Plan and Ewe Performance

Each breed-station group of 48 ewes was randomly assigned for breeding in barn pens 12 by 16 foot in size. Each of six lots of eight ewes was then bred to a fertile ram representing in each case one of the six sire lines under test or a total of 24 breeding lots.

Fertility of each ram was based on an estimate from electro-ejaculated semen obtained in late August and scored for color, sperm concentration, percent motility, rate of motility, and morphology.

All rams estimated to be fertile at the start proved fertile and, with one exception, apparently performed well. The one exception was an Ohio Targhee ram that settled the first 4 of 10 ewes assigned and then appeared to go sterile. Six of 10 ewes failing to conceive to this ram conceived to first service by a catch-up ram after the close of the experimental exposure season of three 17-day periods from September 1 to October 22. The six failing ewes eventually weaned 12 lambs sired by the catch-up ram. This was obviously a case of ram failure in the test period.

For crossbreeding, 24 ewes (four for each of six sire lines) were assigned to the Ohio and Illinois groups and 12 ewes were assigned to the North Dakota group. These ewes were placed so they were bred to rams of the opposite breed (Targhee to Columbia), (Columbia to Targhee) from the other station (Ohio to exchange opposite breed), (exchange group to opposite Ohio breed).

Table 4 summarizes the reproductive performance of ewes by breed-station group and according to use. Total performance of all ewes in the project is also given.

Table 3.--Estrual activity by ewe lambs-1964

Station	Random Bred Pure				Crossbred				Total All Lots
	Columbia		Targhee		Columbia Dam		Targhee Dam		
	Ohio	N. Dak.	Ohio	Ill.	(IT)X(OC)	(OT)X(NDC)	(NDC)X(OT)	(OC)X(IT)	
No. in Lot	33	31	34	28	19	10	12	18	185
Percent in Estrus									
Period 1 (9/1-9/17)	3	2	4	3	0	2	0	3	17
Period 2 (9/18-10/6)	6	9	7	10	4	4	2	6	48
Period 3 (10/7-10/23)	10	3	11	8	9	2	4	7	54
Period 4 (10/24-11/13)	4	7	6	6	2	2	3	6	36
No. Showing Estrus	17	13	22	19	13	6	8	12	110
Percent Showing Estrus	51.5	41.9	64.7	67.8	67.9	60.	66.7	66.7	39.45
No. Cycling	4	7	6	7	2	2	1	8	37
No. With One Estrus Period	13	6	16	12	11	4	7	4	73

Table 4.--Reproductive performance of ewes by breed-station and use grouping at Ohio--1964

Station of Origin	Pure Breeding				Cross Breeding				Total All Lots
	Columbia		Targhee		Columbia		Targhee		
	Ohio	N. Dak.	Ohio	Ill.	Ohio	N. Dak.	Ohio	Ill.	
Ewes Assigned	48	48	48	48	24	12	24	24	276
Ewes Pregnant*	40	44	38**	42	22	11	22	22	241
Ewes Rearing-90 day	36	39	36	40	20	11	22	22	226
No. Fetuses Born	59	65	56	64	35	15	37	37	368
No. Lambs Weaned	52	56	53	54	30	14	31	34	324
Fertility Level	147.5	147.7	147.3	152.4	159.1	136.3	168.2	168.2	152.7
Conception Rate*	83.3	91.7	79.2**	87.5	91.7	91.6	91.7	91.7	83.7
Rearing Percentage:									
Lambs Born/Ewes Assign.	108.3	116.7	110.4	112.5	125	116.6	129.2	141.7	117.4
Lambs Born/Ewes Preg.	130	127.2	139.5	128.6	136.4	127.3	140.9	154.5	134.4
Lambs Born/Ewes Rearing	144.4	143.6	147.2	135	150	127.3	140.9	154.5	143.36
Infant Mortality	13.5	13.8	5.3	15.6	14.3	6.7	19.4	8.1	11.95

*Includes only ewes conceiving during three 17-day periods of exposure to rams.

**One ram accounts for 5 ewes failing to conceive in one lot-same ewes bred on first service to pick up ram.

In this first year when all lots except the North Dakota ewes for crossbreeding were up to full number, some trends seem to be developing. Eighteen percent of 276 ewes assigned September 1 were non-rearing ewes at weaning time. Among the 84 ewes crossbred, 10 percent were non-rearing; among the 192 ewes bred pure, 21.3 percent were non-rearing at weaning time.

In the three 17-day cycling periods, 8.1 percent of the crossbred ewes and 14.58 percent of the ewes bred pure failed to conceive. Fertility level was 148.8 percent among the ewes bred pure and 161.0 percent among the ewes crossbred. If the effect of the one ram going sterile during use is removed, percentages still favor crossbreeding.

Autopsy of Non-Breeding Ewes

Four ewes that failed to yean lambs for two or three breeding-lambing seasons were autopsied in 1964 to ascertain the cause of breeding failure. One ewe showed a cystic-hemorrhaged ovary, one an infection of the uterus, and one infantile ovaries and uterus. The fourth ewe failed to reveal any physiological or pathological condition that might account for breeding failure.

Two ewes that failed to lamb for two successive years were removed from the project but exposed for breeding the following year. One gave birth to twins and the other to triplets. The twins survived but were puny lambs. The triplets were normally presented but required assistance for delivery. All died in the neo-natal period - two at 2 days of age, the third at 11 days. Thus, of 238 ewes initially assigned, six or 2.5 percent have been recorded as non-pregnant two successive years.

Random Replacement of Ewes

Each of the four breed-station groups is to contain 72 ewes: 48 for pure breeding and 24 for crossbreeding, or a total ewe population of 288 head. Each ewe is expected to go through at least two (more if required to hold number) breeding-lambing seasons.

Yearling ewes from random breeding are all kept for replacements within their respective breed-station group. As available, these yearling ewes are used as replacement ewes according to the following schedule: (1) replace all dead or missing ewes; (2) replace unsound ewes - mastitis, relaxed prepubic tendon, umbilical rupture, proplapse, twice nonpregnant, solid black, ewes with cankerous foot infection (chronic foot rot) etc., and (3) replace oldest ewes removed at random on an age class basis.

In the two Columbia breed-station groups at Ohio, all yearling ewes except two in the North Dakota group were used to replace dead, missing, or unsound ewes. This reflects death loss, mastitis damage, pneumonia, chronic bronchitis, pleurisy, and number differentials that normally arise.

In the Ohio Columbia group, the number of yearlings available was less than in other groups because vibrio infection in 1963 hit this group hardest.

In the North Dakota Columbia group, 25 yearling ewes were available and 12 had to be added to the total flock before any replacement could be initiated.

Routine Records

Records covering (1) breeding, (2) lambing, (3) baby lambs, (4) objective weights and body measurements of lambs, (5) subjective body scores, and (6) miscellaneous data have been placed on coded mark sense cards for delivery to the Central Computing Office. The card decks will accumulate until random breeding is completed. Meanwhile, some pertinent data useful in recording progress and for use of the Tri-state Planning Committee have been tabulated.

BREEDING PERFORMANCE OF TARGHEE EWES MAINTAINED UNDER BLUEGRASS PASTURE vs. LADINO CLOVER PASTURE vs. BARN CONFINEMENT MANAGEMENT

D. S. Bell and C. F. Parker

Department of Animal Science

A significant delay in conception among Columbia ewes grazed for the summer and during the breeding season on ladino clover pasture, as compared with similar ewes grazed on bluegrass pasture, was reported by Engle et al. This delay in conception was attributed to abnormal stimulation arising from naturally occurring plant estrogens in the ladino clover, possibly Coumesterol as identified by Bickoff et al. This adverse effect on rate of conception among Columbia ewes seemed to occur within 72 hours after mating, according to Sanger and Bell.

During these experiments, the question was raised whether other breeds might be equally sensitive to ladino clover pasture. For 2 years, however, ladino clover pasture held for such grazing was virtually lost due to exceedingly dry weather conditions. In 1964, ladino pasture was available and was used for grazing from August 21 to October 15. On the latter date, it too had suffered from drouth and frost. However, the test was continued with 2 pounds of hay in addition after October 17.

In the North Central regional sheep breeding project at Ohio, it has been necessary to pen-breed ewes in confinement in the barn, using harvested feed, mostly alfalfa hay, for maintenance. In this experiment, the question has been raised as to whether ewes held under barn confinement and fed hay would breed as readily as ewes maintained outside on bluegrass pasture.

During the 1964 breeding season it was possible to observe the effect of environments on breeding performance of ewes as follows:

1. Ewes grazed on bluegrass pasture.
2. Ewes grazed on ladino clover pasture.
3. Ewes confined to the barn and fed alfalfa hay.

Three lots of 51 purebred Targhee ewes each, varying in age from yearlings being mated for the first time up to ewes 5 years old, were used. These ewes, according to three age classes (yearling ewes, 2-year-old ewes, mature ewes) were randomly assigned to one of the three lots. Four purebred Targhee rams were used and an equal number of ewes (within each of the age groups) were randomly assigned to each ram.

The groups of ewes were assigned to their respective environments on August 21, 1964. The breeding season began September 7, 1964, 17 days after the ewes were placed under their respective environments, but without the presence of the vasectomized rams. Breeding was continued for 52 days or through three 17-day heat cycle periods. In Lot 3 (barn confined), the ewes were in the barn during the day and were allowed in the outside barn lot at night.

Two vasectomized rams wearing raddle-marking harness were placed with each group of ewes on September 7. Once during each 24-hour period, the ewes bearing raddle marks were sorted and individually mated to the fertile ram to which the

ewe had been randomly assigned. After mating, the ewe was branded as bred and returned to her flock after 24 hours in the barn away from the ram.

Table 1 shows the breeding response of three randomly assigned lots of Targhee ewes under the three environments.

During this experiment, the ewes ate whatever they gathered by grazing in Lots 1 and 2 and 4 pounds of alfalfa hay per head per day in Lot 3. The ewes of Lot 3 made the least gain in weight, 7.3 lbs., during the breeding season. The ewes on bluegrass pasture, Lot 1, showed double the gain of Lot 3 ewes while the ewes on ladino clover gained almost 3 times as much as the barn-confined ewes. This relative gain in weight between lots held true for the three age groupings of mature ewes, 2-year old ewes, and yearling ewes within each lot.

All but 4 of the 153 ewes showed estrus during the breeding season of three 17-day cycle periods. One each in Lots 1 and 3 and two in Lot 2 failed to manifest external estrus. The onset of first estrus was essentially the same for all lots and age groups except for the yearling ewes of Lot 3. These ewes seemed to be delayed one heat-cycle period. Of the ewes in this yearling group, 77 percent showed this delay.

Several reasons might explain this performance: (1) failure to adjust promptly to the new environment, (2) a peculiar turn in photoperiodic response, or (3) lowered nutrition due to change from a fresh grass to a hay diet and loss of weight as a result of this change. The explanation remains unknown but the observation seems worth recording.

Conception rates from first mating of 68 percent, 69.4 percent, and 70 percent for Lots 1, 2, and 3 respectively indicate no interference due to environmental treatment. The conception rates for the three lots during the three 17-day cycle periods of 88.0 percent, 87.7 percent, and 96 percent again suggest no influence due to treatment. The slightly higher rate among ewes under barn confinement may indicate a higher rate of identification of ewes in estrus or that less proneness to fatten may enhance conception rate. The difference, however, is small and may be due entirely to chance.

The data covering average fertility level suggest a strong influence due to treatment, especially among the yearling ewes. The fertility level of the mature ewes differed only by 3.3 percent, indicating that mature ewes were not strongly influenced by environment. However, the young or immature ewes in the ladino clover group differed from the barn confined group by 35 percent for 2-year-olds and 28.8 percent for yearlings in favor of the ladino clover environment The immature ewes on bluegrass pasture were intermediate. They were higher than the in-confinement group but lower than the ladino clover group.

The fertility level by age groups between lots follows the same pattern and position as expressed by the ewes under Average Gain in Weight by age groups in each of the three lots. These data suggest that the differences are due to level of nutrition and seem to arise from so-called flushing effect.

It had been observed previously that mature ewes which normally exhibit a high fertility level are difficult to stimulate to a still higher level. On the other hand, immature ewes inclined to a low level of fertility or mature ewes of a normally low level of fertility are responsive. These data tend to confirm such an observation.

Table 1.--Breeding response of Targhee ewes under three environments, 1964-65

Treatment	Lot 1	Lot 2	Lot 3
	Bluegrass Pasture	Ladino Clover Pasture	In Barn - Alfalfa Hay
Number Ewes Assigned	51	51	51
Av. Weight at Start*			
All Ewes	145.4	143.4	144.1
Mature Ewes	152.3	148.1	151.0
2-year-old Ewes	139.6	145.5	139.5
Yearling Ewes	132.8	132.3	132.1
Av. Gain per Ewe**			
All Ewes	14.2	20.2	7.3
Mature Ewes	13.0	20.7	8.9
2-year-old Ewes	19.9	25.2	7.3
Yearling Ewes	14.1	18.0	4.3
Number Ewes in Estrus	50	49	50
Av. No. Days to First Estrus***			
All Ewes	13.6	16.9	18.8
2-yr.-old & Mature Ewes	16.6	14.4	10.0
Yearling Ewes	11.2	17.7	29.6
No. Ewes Conceiving First Estrus	34	34	35
No. Ewes Conceiving - Three 17-day cycles	44	43	48
Av. No. Days to Achieve All Pregnancies	17.7	20.2	23.6
Total Number Fetuses Born	74	79	76
Av. Fertility Level			
All Ewes	168.2	183.7	156.7
Mature Ewes	184.6	188.9	182.7
2-yr.-old Ewes	166.7	180.0	116.7
Yearling Ewes	133.3	172.7	123.1
Total Number Fetuses			
Mature Ewes	48	51	53
2-yr.-old Ewes	10	9	7
Yearling Ewes	16	19	16

*Starting date - August 21

**Between August 21 - November 5.

***Days beyond September 7 when breeding began.

Since the greatest proportion of ewes in the North Central regional breeding project are yearlings and 2-year-old ewes, it seems important that the relation of age to response from flushing under differing environmental feeding and housing conditions should be examined further. The ability of young ewes to care for and raise lambs born in multiple birth, as compared with older ewes, should also be examined.

The data from this experiment have been analyzed statistically using the least squares method outlined by Harvey for groups of unequal sub-class numbers. In this analysis, type of birth was listed as single, multiple, and multiple raised single. The number of triplets born was the same in all lots (two sets each). The in-barn confined group, however, benefited from one set of quadruplets from a mature ewe.

Sire difference for days to lambing was significant, difference for days to lambing due to treatment was highly significant, and the interaction of age x treatment with respect to time of lambing was highly significant. This was due almost entirely to the yearling ewe performance under barn confinement. The means for this interaction of age x treatment in terms of days to lambing were as follows:

	Age		
Treatment	Mature	2-yr.-olds	Yearlings
1. Bluegrass	52.91	60.96	53.51
2. Ladino	55.84	56.62	48.67
3. In-Barn	56.79	60.05	75.45

Difference in the means (column 3-line 2 vs. column 3-line 3) for yearling ewes between treatments 2 and 3 was 26.78 days or the average number of days the yearlings under barn confinement lambed later than yearlings on ladino clover pasture. The difference between bluegrass and barn confinement was 21.94 days. This difference was also measured as a difference in terms of onset of estrus between these respective groups. Apparently the yearlings under barn confinement were delayed one full heat-cycle period when compared with those under either pasture management.

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RAM EFFECT ON EWE FERTILITY

C. F. Parker and D. S. Bell

Department of Animal Science

Reproductive performance is highly associated to production efficiency and is considered the most important economic trait by the sheep producer. Lamb crop percentage is also directly related to the rate of genetic progress possible through selection because of its influence on replacement rate and selection intensity.

Most animal husbandmen believe that reproductive performance is primarily a function of the female, with the effect of the male being unimportant.

During the past 3 years, numerous investigations have been conducted at the Ohio Agricultural Research and Development Center to determine if the ram is an important cause of fertility differences among similar groups of breeding ewes. Studies have involved the Columbia and Targhee breeds of sheep. Data have been collected from 73 rams and 778 ewes.

Each year 8 to 12 ewes were randomly assigned to a breeding pen and exposed for three estrous periods to an unselected ram of the same breed. All breeding groups were maintained under uniform drylot conditions at the same location during the mating season and subsequently were managed together during the post-breeding and lambing periods.

The data were analyzed by methods of least squares with constants fitted for the effects of ram breed, years, and age of ewe. Body weight of the ewe at breeding time was included in the analysis as a continuous variable. Date of lambing was included as a continuous variable in the analysis involving only those data from lambing ewes.

Statistical analyses of the data showed that rams can be a highly significant source of the variability in ewe fertility among similar breeding groups. Table 1 shows the differences in the least squares means between the top 10 percent and the bottom 10 percent of the sires for the different measures of reproductive performance during the first two years of the study.

Table 1.--Average of least squares means for five high fertility and five low fertility rams

	Live Lambs Per Ewe			
	Exposed		Lambing	
	At birth	At 10 days	At birth	At 10 days
Overall Average	1.17	1.05	1.37	1.26
High Fertility Rams	1.66	1.55	1.78	1.72
Low Fertility Rams	.63	.57	.91	.82
Ram Difference(H-L)	1.03	.98	.87	.90

The fertility rate during the 1965 lambing season was found to be lower than in the previous 2 years. However, sizeable differences among breeding groups were observed. One group of 11 ewes dropped 19 lambs with 17 alive at 10 day postpartum. Another group of 11 ewes dropped a total 10 lambs with 5 alive at 10 days of age. Twelve ewes in a third breeding group were all fertile but only two sets of twin births were observed.

The results from the initial phase of this study show that the ram can be a highly significant cause of the fertility differences among similar groups of breeding ewes.

Ram Semen Evaluation

Semen studies were conducted concurrently to determine if rams with different reproductive capabilities could be recognized prior to the breeding season. Semen samples were collected by means of electro-ejaculation a few days prior to the September 1 breeding date. A microscopic examination of the fresh semen was employed similar to what might be applicable under field conditions.

Traits subjectively evaluated by two scorers working independently were: semen color, rate of cell motility, percent live spermatozoa, percent abnormal spermatozoa, and sperm cell concentration. Subjective palpation scores were recorded for the size and texture of testes and epididymides at the time of semen collection.

Semen characteristics and body measurements of the rams were related to the average fertility performance of the breeding ewes. A multiple regression analysis indicated that the set of ram measurements most highly indicative of ewe fertility included body weight, epididymis size, semen color, and percent abnormal spermatozoa. Of the fertility variation among ewe breeding groups, 25 percent was associated to this set of ram measurements. Although these results were found to be statistically significant, their practical value for the selection of individual rams on their reproductive ability is limited. Greater accuracy is needed for predicting ram fertility before these methods can be of value to the sheep producer.

Six Targhee rams were selected from a group of 11 stud quality rams on the basis of semen evaluation. Three rams were considered to be highly fertile on the basis of semen scores and three were estimated to be of low fertility. Each ram was mated to 24 Targhee ewes. The lambing data from these ewes are presented in Table 2.

The results from this study indicate that subjective semen evaluation is of limited value for discrimination among rams with respect to their influence on ewe fertility.

Heritability Estimates of Ram Semen Traits and Body Scores

A third phase of this investigation was to estimate the additive genetic variation for ram semen traits and certain body measurements. The appearance of the sperm cell may be valuable in identifying rams with superior genetic constitution for fertility. Therefore, a knowledge of the genetic variability of these characteristics is imperative.

Table 2.--Ewe fertility data from matings to Targhee rams selected on high and low semen quality scores

Group	Semen Scores*					Live Lambs Per Ewe			
						Exposed		Lambing	
	Concentration	Motility	Percent Alive	Color	Percent Abnormal	Birth	At 10 da.	Birth	At 10 da.
High									
629	1	2	95	6	5	1.82	1.60	1.81	1.59
720	1	2	95	5	5	1.72	1.61	1.73	1.60
624	3	3	85	5	10	1.18	1.00	1.69	1.44
Av.	1.7	2.3	91.7	5.3	6.7	1.57	1.40	1.74	1.55
Low									
355	4	5	80	4	15	1.73	1.65	1.81	1.73
448	7	8	70	5	20	1.73	1.46	1.72	1.44
740	9	6	60	5	25	1.58	1.31	1.67	1.39
Av.	6.7	6.3	70.0	4.7	20	1.68	1.47	1.73	1.52

*Semen color was scored 1 through 7 with 7 being the most desirable color. Concentration and rate of motility were scored on a 1 to 15 scale with 1 excellent and 15 very poor.

Data from 175 randomly chosen Columbia and Targhee yearling and 2 year old rams from 45 different sire groups were analyzed to calculate estimates of heritability among subjective scores of ram semen traits and testes and epididymides measurements. Genetic variances were estimated from the paternal half sib components derived from the least squares method of analysis. The estimates of heritability are presented in Table 3.

During the first year of the study, a late July semen collection was made followed by another collection 4 weeks later. A duplicate sample was available on 84 different rams. These data were correlated to obtain estimates of repeatability, which are presented in Table 3.

Table 3.--Estimates of heritability and repeatability for certain ram semen traits, testes and epididymides scores

Trait	Heritability (k=3.65 for 45 rams)	Repeatability (n=84)
Semen Color	.11 ± .28	.033
Rate of Motility	.23 ± .29	-.019
Percent Alive	-.06 ± .26	.070
Percent Abnormal	.19 ± .29	.23
Concentration	-.28 ± .23	.059
Testes Size	.91 ± .33	.694
Testes Texture	.49 ± .31	.431
Epididymis Size	.12 ± .28	.260
Epididymis Texture	.47 ± .31	.297

All palpation scores with the exception of epididymis size were found to be rather highly heritable. The heritability estimates for semen traits were low except for the values obtained for the rate of sperm motility and percent abnormal spermatozoa.

Heritability of Ram Fertility

A question of major importance is whether the male offspring resemble their sires with respect to their influence on ewe fertility. To provide an answer to this question, data were analyzed by means of regression. The least squares means for ewe fertility from unselected sons was regressed on the least squares means of their sires. Heritability estimates for number of lambs born per ewe exposed and lambing at birth and 10 days post-partum were calculated. These heritability estimates are presented in Table 4.

Table 4.--Estimates of heritability for measures of ram breeding performance (24 pairs)

Lambs Born:	
Ewe Exposed	.31
Ewe Lambing	.33
Lambs Alive at 10-day Post-Partum:	
Ewes Exposed	-.43
Ewes Lambing	-.36

Although the data are limited, it appears that ram fertility as measured by number of lambs born per ewe exposed and per ewe lambing is moderately high in heritability. This finding indicates that some genetic improvement in ewe fertility could be accomplished from selecting rams from sires whose fertility record is high. Sires were equally divided into a high and low fertility group with observed differences of 1.58 and 1.32 lambs born per ewe. The unselected sons from these rams had fertility performances of 1.42 and 1.38, respectively, based on the number of lambs born per ewe lambing.

The findings to date from this station indicate strongly that the ram can have a highly significant influence on the reproductive performance of the ewe. The specific cause or causes of this effect are not well defined. Subjective semen evaluation has been of little value in accurately discriminating among rams with respect to their fertility values. Limited information indicates certain aspects of ram fertility may be heritable and therefore subject to genetic change through selection.

CREEP FEEDING NATIVE LAMBS

A Comparison of the Performance of Ewes and Lambs when Managed under Separate Rearing Groups of Twins, Singles, and Mixed Twins and Singles

J. K. Judy, J. H. Cline, W. J. Tyznik, C. F. Parker, and D. S. Bell

Department of Animal Science

Introduction

Management has been recognized as an important contributing factor in the economy of creep feeding native lambs. Current interest in weaning at younger ages, lambs that are dropped during the winter months, has prompted an investigation of differences in the amount of feed required to finish the lamb, as well as the amount required to maintain the nursing ewe.

This experiment was designed to test the effects of three different types of rearing on the performance of ewes and their lambs. The research was conducted as part of State Project No. 323.

Procedure

Eighty ewes consisting of 48 5-year-old Westerns, 8 4-year-old Westerns, and 24 4-year-old Targhees were randomly allotted, within type and weight group, to eight breeding pens. Eight production tested Shropshire rams were randomly assigned to the breeding pens and introduced to the ewes on August 18. Mating was allowed to extend over the period of three estrous cycles. During this time, the ewes were confined in the barn and maintained on a daily ration of 4 lbs. of medium quality mixed legume hay. Approximately 4 weeks prior to lambing, a concentrate ration consisting of 3 parts shelled corn, 3 parts oats, and 1 part linseed oil meal pellets was fed at the rate of 3/4 lb. per head daily. After lambing, the rate was increased to 1 lb. Hay was fed at the rate of 4 lbs. per head daily throughout the feeding period. Individual ewe weights were recorded within a 6-hour period after lambing and again at weaning. All ewes were shorn approximately 30 days prior to lambing.

Lambs were allotted, as they reached 7 days of age, into three treatment groups according to age, sex, sire group, and type of rearing. Individual lamb weights were recorded at 2-week intervals. Lambs were weaned as close to 90 days of age as the 2-week interval of weighing allowed.

During the creep feeding period, the lambs were confined to the creep for approximately 1 hour during the morning and evening feeding periods. Continuous light and a separate water supply were supplied in each creep. A ration of 80 percent cracked corn and 20 percent soybean oil meal pellets (fortified with 200 mg. aureomycin per pound) was supplied in a self-feeder to each lot. A second self-feeder in each lot contained dehydrated alfalfa pellets containing

15 percent protein.

Feed consumption was determined for each of the 2-week weigh periods. Lambs were removed from the test and slaughtered approximately 18 hours following the weigh day at which they first reached either 94 lbs. or 150 days of age.

Results

Ewe response to treatment as measured by change in weight during the nursing period was extremely variable. It ranged from a loss of 43 lbs. to a gain of 11 lbs. There appeared to be little effect of lamb gains on the gain or loss in weight of the ewes.

Time of lambing appeared to have a noticeable influence on the weight loss by ewes. One group of 18 ewes nursing twins and lambing between January 12 and January 26 experienced an average weight loss of 13.3 lbs. during the nursing period. A comparison group of 15 ewes nursing twins but lambing between January 28 and March 3 experienced a weight loss of 25.5 lbs. A third group of 16 ewes consisting of 6 ewes nursing twins and 10 ewes nursing singles experienced an average weight loss of 9.0 lbs. The ewes nursing singles in this group lost an average of 8.7 lbs. while those nursing twins lost an average of 9.5 lbs. The fourth group of 25 ewes all nursed singles and experienced a weight loss of 8.4 lbs.

Table 1 gives data on weight loss by ewes during the nursing period by type of rearing and type of ewe.

Table 1. -- Average weight loss by ewes during nursing period

Number of Ewes	Treatment	Weight Loss in Lbs.
74	Total Experiment	13.2
22	Targhee	8.5
52	Western	15.2
39	All Ewes Nursing Twins	17.4
7	Targhee	15.1
32	Western	17.9
35	All Ewes Nursing Singles	8.5
15	Targhee	5.5
20	Western	10.8

Lamb response to treatment was evident only in the instance of twin lambs. Twin lambs reared in the group comprised of both single and twin lambs gained slightly faster than twin lambs reared in the groups comprised entirely of twin lambs. The rate of gain of single lambs reared in the group comprised of both single and twin lambs was nearly identical with those reared in the group comprised entirely of single lambs.

Tables 2 and 3 give data on lamb performance and creep feed utilization during the period from the time the lambs were exposed to the creep until they were weaned.

Table 2. -- Lamb performance during the period from exposure to creep until weanir

	Treatment	Number of Lambs	Average Age at Start, Days	Average Initial Weight, Pounds	Average Weaning Age, Days	Average Weaning Weight, Pounds	Averag Daily Gain
Lot I	Reared as twins and dropped between Jan. 28 and Mar. 3	30	13.2	17.1	83.2	64.5	.677
Lot II	Reared as twins and dropped between Jan. 12 and Jan. 26	36	13.2	17.1	83.2	64.7	.680
Lot III	Reared as mixed group of twins and singles and dropped between Jan. 16 and Mar. 3	21	13.5	18.9	83.5	71.9	.757
		9sgl	13.8	21.7	83.8	78.2	.807
		12tw	13.3	16.8	83.3	67.1	.719
Lot IV	Reared as singles and dropped between Jan.13 and Mar. 10	24	13.6	21.9	83.6	77.5	.794

Table 3. -- Utilization of creep feed by lambs during the period from exposure to creep until weaning

Treatment	Pounds Feed Per Pounds Gain			Pounds Feed Consumed Per Day		
	Alfalfa Pellets	Concentrate	Total Feed	Alfalfa Pellets	Concentrate	Total Feed
Lot I	.58	1.22	1.80	.39	.83	1.22
Lot II	.45	1.28	1.73	.31	.87	1.18
Lot III	.64	1.15	1.79	.48	.86	1.34
Lot IV	.56	1.22	1.78	.43	.95	1.38

STUDIES OF THE PROTEIN AND ENERGY REQUIREMENTS OF GROWING-FINISHING LAMBS

R. R. Johnson, J. H. Cline, and D. S. Bell

Department of Animal Science

Adequate protein in all livestock rations is essential for maximum rate of growth. Protein also represents one of the more costly ingredients in the ration. So continual efforts are made to determine more exactly the optimum level of protein for growing-finishing lambs.

Although some earlier references suggest 10 percent crude protein is adequate for sheep rations, more recent research indicates that considerably higher levels of protein might be needed for maximum growth and feed efficiency among nursing lambs.

In recent years the energy content of lamb rations has been increased by increasing the proportion of concentrate to roughage. Generally, faster rates of growth and finishing have been produced but these are often dependent on higher protein levels. New York workers found that lambs fed high energy rations apparently required more protein than those fed low energy rations to maintain feed intake and growth rate. In Missouri, lambs self-fed 14 percent protein high energy pelleted rations gained faster and more efficiently than those fed 11 percent protein rations. In a recent report, Illinois workers calculated that the protein content for rations fed to early weaned lambs was optimum at 17.7 percent for maximum gains and 19.1 percent for highest efficiency.

In addition, considerable emphasis has recently been placed on the use of high urea supplements, thus utilizing a source of nitrogen which is more economical. Research workers in Illinois, Indiana, and other stations have demonstrated the use of supplements containing urea as the major source of nitrogen in combination with dehydrated alfalfa meal, molasses, ground corn cobs, and various other materials.

The study reported here was initiated to investigate the level of protein required in a high energy pelleted feed for growing-finishing lambs. A total of 146 lambs were allotted randomly to three lots according to sex, sire, type of birth (single, twin or triplet), and date of birth. The lots were self-fed the rations shown in Table 1 as a creep ration prior to weaning and as a growing-finishing ration after weaning. Water was available at all times and trace mineralized salt was provided free choice.

Performance of the lambs from 30 to 90 days or weaning and from 90 days to close of the test were analyzed statistically to remove effects of sex, sire, and type of birth. The results are shown in Table 2.

Rations 1 and 2 were designed to compare the performance of lambs fed a 50 percent roughage ration with two levels of protein, 12 percent and 16 percent. Upon analysis, the levels actually were 13.6 and 17.2 percent. Ration 3 was designed to determine if performance of lambs could be improved by increasing both the energy and protein content of the ration.

As shown in Table 2, the differences in gains of the lambs fed the three rations were small and, in fact, non-significant. Thus it did not appear that extra protein was beneficial in the ration tested here. Furthermore, the addition of extra energy, as in Ration 3, did not improve performance of the lambs. Both gains and pellet consumption in all three lots were quite good.

Table 1.--Composition of rations for protein-energy lamb feeding trial

Ingredients	Percentage Composition Air Dry Basis*		
	Ration 1	Ration 2	Ration 3
Ground 2nd Cut Alfalfa Hay	50	50	35
Soybean Oil Meal	0	11	25
Ground Shelled Yellow Corn	37	26	36
Native White Oats	9	9	0
Molasses	3	3	3
Steamed Bone Meal	1	1	1
Calculated Crude Protein**	12.3	16.1	19.7
Analyzed Crude Protein**	13.6	17.2	19.2
Calculated TDN	63.3	63.1	68.0

*In addition to the major ingredients, 15 gm. aureomycin, 1,135,000 I.U. vitamin A and 113,500 I.U. vitamin D were added per ton of each ration.

**Air dry (as fed) basis.

Table 2.--Performance of lambs on 12, 16, and 20 percent protein pellets

	Ration 1 12% C.P.	Ration 2 16% C.P.	Ration 3 High Energy 20% C.P.
No. Lambs at Close	43	46	46
Av. 90-Day Weight, lbs.	68.3	64.5	68.8
Av. Gain, 30-90 Days, lbs.	39.5	37.5	39.8
Av. Gain, 90-Close, lbs.	23.2	23.4	23.6
Av. Daily Gain, 30-90 Days, lb.	0.66	0.62	0.66
Pellet Consumption, lb./head			
Pre-weaning (88 days)	0.87	0.89	0.90
Post-weaning (58 days)	3.25	3.57	3.00

VISUAL AND ULTRASONIC EVALUATION OF CREEP FED SLAUGHTER LAMBS

C. F. Parker, D. L. Davis, and J. K. Judy

Department of Animal Science

The increased consumer demand for leaner meat has stimulated a general interest among livestock people to learn more about how to recognize meatiness in breeding and slaughter animals. The most common and least complicated method of live animal evaluation has been visual appraisal. However, during the past 10 years, an ultrasonic method has been used experimentally to determine fatness and leanness in cattle, sheep, and swine.

Ultrasonics can be defined as the science and technology of high-frequency sound. High-frequency sound waves can be directed upon certain areas of the live animal for an objective evaluation of the thickness and surface area of various kinds of body tissue. When the sound waves strike an object, an echo is returned and received by the apparatus generating the sound. These echos differ according to the density of the tissue. The echo is subsequently changed into electrical energy and these electrical signals are amplified into a series of light signals. Control of the generated light signals allows a direct reading of the different kinds of tissue and therefore gives more information about the body composition of the live animal.

Two important measures of lamb carcass value are the degree of fatness and muscle thickness. Numerous studies have indicated that fatness is the largest single factor in determining the proportion of edible meat from the lamb carcass. Thickness of muscling is undoubtedly more important in lambs than in any other meat animal species because of its influence on the amount of lean in the high priced rib and loin area of the carcass. More must be learned about how to recognize and produce meatier carcasses if lamb is to compete favorably with other meats for the consumer dollar.

The purpose of this study was to compare the relative accuracy of visual vs. ultrasonic methods for estimating carcass meatiness of creep-fed slaughter lambs. Data were collected from 100 lambs from black-face western crossbred ewes and sired by Hampshire rams. The lambs were removed for slaughter when they weighed 94 pounds or were 150 days of age, whichever came first. The lambs ranged in age from 14 to 22 weeks at the time of slaughter.

Fat thickness and loin eye area estimates were recorded for each lamb by four experienced judges independently handling the lamb just prior to slaughter. Ultrasonic measurements were taken for fat thickness and loin eye muscle on the left side of the lamb between the 12th and 13th ribs. A Branson Sonoray Model 52 instrument equipped with a 2.00 megacycle transducer and Polaroid land camera was used to record ultrasonic measurements.

The lambs were measured ultrasonically while being restrained in a standing position with the use of a special crate designed to suspend the lambs without abnormal muscle tension. All lambs were slaughtered and the carcasses measured at the Ohio State University Meats Laboratory. The carcasses were chilled at least 24 hours and subsequently separated between the 12th and 13th ribs for carcass measurement.

The carcass fat thickness measurements were taken from the medial, middle, and lateral edges of the loin eye muscle. Acetate tracings of the ultrasonic loin eye pictures and the actual loin eye muscle measured from the fore saddle were made and muscle area was calculated from the tracings with the use of a polar planimeter.

The averages and standard deviations for live and carcass measurements of fat thickness and loin eye area are presented in Table 1.

Table 1.--Averages and standard deviations for visual, ultrasonic, and carcass measurements of fat thickness and loin eye area

Measurement	No. of Lambs Measured	Average	Standard Deviation
Carcass Loin Eye Area	100	2.25	.22
Av. Visual Loin Eye Area	82	2.22	.13
Ultrasonic Loin Eye Area	100	2.15	.21
Carcass Fat Thickness	100	.285	.07
Av. Visual Fat Thickness	82	.287	.06
Ultrasonic Fat Thickness	100	.285	.07

The averages shown in Table 1 indicate that both visual and ultrasonic estimations were relatively accurate in estimating the group average for fat thickness and loin eye area. The individual relationships between live measurements and carcass measurements were statistically determined by calculating the linear correlation coefficients given in Table 2.

Table 2.--Simple correlation coefficients among visual, ultrasonic and carcass measurements for average fat thickness and loin eye area

Measurement	Visual[≠] LEA	Ultrasonic LEA	Visual Fat Thickness	Ultrasonic Fat Thickness	Carcass Fat Thickness
Carcass LEA	.595**	.612**	.247*	.232*	.195*
Visual LEA		.469**	.521**	.444*	.448**
Ultra LEA			.329**	.204*	.216*
Visual Fat Thickness				.294**	.329**
Ultra Fat Thickness					.902**

[≠]The visual measurements were recorded on 82 lambs while the ultrasonic and carcass measurements were taken on 100 lambs.

* and

**Indicate that a correlation value of this size or larger will occur due to chance in less than 5 percent and 1 percent of the time, respectively.

The correlation coefficients for average visual (r = .595) and ultrasonic easurements (r = .612) of loin eye area were almost identical and considered o be of practical significance. These values indicate that approximately 36 ercent of the variation in carcass loin eye area is associated with live stimates of visual and ultrasonic loin eye area. However, a closer examination f the data show that 72 and 63 percent of the visual estimates and ultrasonic stimates were within plus or minus .2 square inch, respectively, of the actual oin eye area.

The average ability of the visual appraisers to accurately estimate those lambs ess than or greater than 1 standard deviation from the average was found to be low. he average deviation at these points (less than 2.03 and greater than 2.47 square nches) was +.15 and -.31 square inches, respectively.

The ultrasonic fat measurements were found to be highly related (r = .902) o carcass fat thickness. This result indicates that approximately 80 percent of he variation in carcass fat thickness was associated to the ultrasonic fat easures. Of the ultrasonic fat measures, 97 percent were within plus or minus .05 inch of the actual carcass measurement. The correlation between the visual at measures and the actual carcass fat thickness was low (r = .329).

Presented in Table 3 are the correlation coefficients between the individual isual measurement and carcass measurements. Appraiser A's fat estimates were poorly related to the carcass measurements for fat thickness. This low correlation coefficient accounts somewhat for the lower relationship between the average visual fat thickness and carcass fat thickness.

A correlation coefficient of .453 was calculated for average fat estimates on 64 lambs by appraisers B and C and the carcass fat measurements. A correlation of .630 has been calculated between the average visual estimates of appraisers B and C and actual fat thickness on another set of 68 lambs slaughtered this year.

Table 3.--Simple correlation coefficients between individual visual estimates and carcass measurements of fat thickness and loin eye area

Appraiser	Fat Thickness		Loin Eye Area	
	r	Average	r	Average
A/	-.01	.343	.42**	2.19
B//	.34**	.267	.46**	2.22
C/	.43**	.300	.48**	2.27
D//	.34**	.281	.45**	2.20
Carcass average		.285		2.25

/Evaluation on 54 lambs.

//Evaluation on 82 lambs.

**P < .01

The results from the test show that visual evaluation based on the average of more than one observer can be as accurate as ultrasonic measurements of loin eye area. However, it was noted that lambs deficient or heavily muscled were difficult to accurately appraise by visual observation. The accuracy between ultrasonic fat thickness and carcass fat thickness over the loin eye are observed to be high.

Other researchers have reported that fat thickness can be estimated rather accurately with ultrasonic methods. Ultrasonic methods may provide another tool for more accurate selection for meatiness in breeding and slaughter sheep in the future.

FORAGES FOR SUMMER FEEDING OF FARM FLOCKS

R. W. Van Keuren

Department of Agronomy

Traditionally sheep producers have depended largely on grazing for summer feeding. While pasture can provide adequate nutrition, the kind of pasture, plant maturity, grazing pressure, and other factors can markedly influence pasture feed value and animal gains.

Permanent pastures, largely Kentucky bluegrass and white clover, provide the bulk of the sheep pasture in Ohio. With adequate fertilization and management, these provide good pasture in early spring and again in the fall. Neither species is drought-tolerant and bluegrass-white clover pastures are not reliable during the summer months. During early spring, a good bluegrass pasture will carry 6 to 8 ewes per acre.

A Virginia study reported that early February lambs gained a half pound per day on bluegrass pasture and their dam's milk from April 20 until weaned (late May to mid-July). They graded high good to low choice. The ewes and lambs were drenched with phenothiazine prior to going on pasture and had constant access to phenothiazine-salt mixture while on pasture. To obtain good gains, it is important not to overgraze nor to let the pasture get mature.

To improve the quality and yield of bluegrass pastures, both birdsfoot trefoil and ladino clover have been seeded with bluegrass. Studies in Ohio and elsewhere have shown that ladino is high yielding and provides good gains. However, it is short-lived and lacks drought tolerance.

Birdsfoot trefoil, on the other hand, was found to be an excellent companion legume in bluegrass permanent pastures for northern Ohio. It is drought-tolerant and provides high quality forage. In addition to increasing the yield of bluegrass pasture, trefoil provides grazing during the summer months when the bluegrass is often virtually dormant because of drought. A recent Ohio study showed that rotational grazing is necessary to maintain trefoil in a pasture.

The Empire variety of birdsfoot trefoil persisted better than Viking in this 6-year study at Wooster. Trefoil had almost disappeared under continuous grazing. A simple three-pasture rotational grazing program will maintain trefoil, with 5 to 6 weeks of recovery allowed before grazing each area again. An adequate level of lime and fertilizer must also be maintained. The 1965 study showed weaned lambs gaining up to a half pound per day on bluegrass-trefoil pasture during the first part of the grazing season (up to the time this report was written).

Alfalfa is an excellent pasture legume for fattening lambs. With early February lambs, gains of more than a half-pound per day during May and June were obtained in Washington studies. The lambs graded high good to low choice at weaning time.

Again management is very important. A rotational grazing system is necessary to maintain the alfalfa. Timothy or bromegrass should be sown with the alfalfa. Alfalfa-grass is the highest yielding forage mixture. After weaning the lambs, grazing such pasture may result in dry ewes becoming too fat. It may be better use of alfalfa for the remainder of the season to harvest for winter feed, moving the dry ewes to other pasture.

Orchardgrass with nitrogen is a very productive grass in Ohio. Although high carrying capacity and good lamb gains can be obtained, it presents management problems in utilization. Orchardgrass matures early in the spring and it is difficult to use it rapidly enough to keep the pasture in reasonably good quality. Usually somewhat lower lamb gains can be expected from orchardgrass. About a third of a pound per day were obtained in Virginia and Washington studies with fattening lambs up to weaning.

Sudangrass and sorghum-sudangrass crosses can be used as summer annual pastures. Seeded in May, three to four grazings can be obtained from about July 1 until frost. With adequate fertilizer and moisture, 10 to 12 mature ewes per acre can be carried during this period. Ten acres will carry 100-120 ewes.

Such pasture is excellent for summer-feeding the flock and to supplement bluegrass permanent pastures. Sudangrass or sorghum-sudangrass should not be grazed until 24 inches tall. Rotational grazing should be used to allow recovery between pasturing. This will provide the most feed as well as better utilization of the crop.

Using forages as green-chop or as stored-feed provides more feed per acre than grazing. Some dairymen and beef feeders have switched to these summer-feeding systems. Ohio studies have shown that 50 percent more feed per acre can be obtained from green-chop than from grazing alfalfa-bromegrass and an additional small increase obtained from stored-feed. In feed-short years, farmers with a forage-chopper may wish to consider this method of feeding. The use of green-chop also avoids the problem of internal parasites resulting from grazing.

A preliminary report from Beltsville showed that early February lambs fed green-chop from April 12 to 120 days of age in early June gained 0.51 pounds per day. The green-chop was winter wheat for 2 weeks, followed by a ladino clover-orchardgrass mixture. Lambs grazing the same forages gained 0.42 pounds per day when no special efforts were made to control internal parasites and 0.53 pounds per day when special efforts were made to obtain parasite-free conditions. Studies with dairy and beef cattle have also shown that similar animal response (milk production or daily gains) can be obtained with green-chop as with grazing.

The management problem is to provide as good a forage by chopping as by grazing. A common failing with green-chop is allowing the forage to become too mature. This sharply reduces the animal gains because of the decline in forage digestibility and intake.

The lambs in the Beltsville study consumed from 3 pounds of green forage per day (0.65 pounds dry matter) in late April when feeding began to about 8 pounds (1.25 pounds dry matter) in late June. Ewes will consume about 2 to 3

pounds of dry matter daily, which is about 10 to 15 pounds of green forage.

Alfalfa-bromegrass harvested as green-chop has averaged about 4 tons of dry matter per acre for the last 5 years in studies at Wooster. These same studies indicate that sudan and sorghum-sudangrass materials will yield 3 tons or more per acre of dry matter harvested as green-chop.

Summary

A number of forages can be used for summer feeding farm flocks in Ohio. Permanent bluegrass pastures can be markedly improved by adding birdsfoot trefoil, using adequate lime and fertilizer, and managing properly. Alfalfa-grass is the highest yielding mixture and, as with trefoil, requires rotational grazing to maintain the legume. The summer annuals, sudangrass and sorghum-sudan crosses, provide good pasture during July and August when bluegrass pastures are short.

The use of green-chop may be a consideration if a farmer is short of summer feed and has a forage-chopper available. Providing high quality feed for fattening lambs, adequately liming and fertilizing pastures, and following good grazing practices are all important if the farm flock is to perform efficiently.

CHARACTERISTICS OF CONSUMER-PREFERRED LAMB CARCASS

L. E. Kunkle

Department of Animal Science

Someone has observed that the consumer is the only indispensable person in the sheep industry.

Presumably tenderness is an important attribute of meat. Yet Miss Church did not receive a single comment on tenderness in over 7000 letters from readers. Flavor is a much used meat characteristic, along with aroma that excites sensory responses. Some laud the aroma that wafts from the kitchen as lamb is roasted, some cannot tell it is lamb, and some might even be critical of the odor.

The use of mutton and lamb is recorded in the Bible. The lamb was the personification of purity and innocence among animals in early times. Historically, sheep were a source of wool for clothing and were salvaged as mutton to eat.

Fifty years ago some courageous sheepmen, including W. C. Coffey and D. J. Kays, spoke out against mutton and were successful in removing yearling wethers from show ring classifications. They strengthened the case for efficient meat production through lamb that could be marketed at 6 months of age from ewes' milk and good pasture.

Twenty-five years ago, D. S. Bell was encouraged by Paul Gerlaugh to produce ewes with enough mature size to mate with rams that would stimulate growth in the offspring and produce marketable quantity and quality of lamb in southeastern Ohio. The project included a control flock of native Merinos as well as western type ewes bred to rams that represented the Down breeds.

The progeny of this sheep improvement project were consigned to carcass yield test. This project furnished a carcass yield study which was the initial edible portion effort of the staff of the Meats Laboratory.

Many lambs which moved from pasture in August and September and all by December had carcasses which were short shanked, with short plump legs, wide backs, and meaty shoulders. Such carcasses were graded choice, high good, and a few prime.

The Merino lot of lambs were to weigh 90 lbs. before going to test slaughter. Such lambs usually carried over into the following calendar year and were fed to make off test weight by May 1.

Holding pen estimates indicated a wide contrast in predicted yield or dressing percentage. Carcass appraisal and grade implied a wide contrast between the yield of boneless meat from the more compact as opposed to the long angular carcasses. This preconceived judgment that favored the shortest, widest, and deepest was illustrated by comparing the bites of fried chicken from a barred rock and a leghorn fryer.

The results of this lamb carcass comparison were startling at the time because the range of average yield of edible portion fell within 74 and 69 percent respectively. Bone content was similar, so fat deposition was the chief contributor to the 5 percent range difference. The real lesson gleaned from this effort was the additional time required to let the Merino controls make minimum weight and grade.

The profile view of the carcass provides opportunity to think about geometry and composition. The basic skeleton of bones is the framework upon which edible portion, muscle, grows along with the connective tissue. The entire carcass is 100 percent of the value.

When a carcass is cut into wholesale regions the legs should be 33 percent of the weight but will likely contribute 40 percent or more of the wholesale value. The back, source of rib and loin chops, is less than 25 percent of the weight but likely will sell for 37 percent of the wholesale value. The remaining 40 percent of weight will do well to return the remaining 23 percent of value.

What do consumers prefer in lambs?

1. Meat to eat--a small rib lamb chop isn't enough. A 50 lb. lamb carcass needs 2.5 square inches of muscle to show in the last rib chop.

2. Enough fat to identify lamb and to protect the carcass surface--1/10-inch and not more than 3/10-inch of fat on the rib chop surface.

3. A kind of muscle that is equivalent to USDA choice or better.

These carcass goals are attainable in 1965 by breeding and management.

Research in lamb meat production is currently underway in Ohio, Missouri, Texas, New Mexico, California, Colorado, North Dakota, Iowa, Wisconsin, Illinois, and other states. Experiment Station staffs are striving to assist in lamb meat production so the consumer will use more than 2 percent of his meat dollar for lamb.

SHEEP DISEASES

A. H. Hamdy, D. R. Redman, W. D. Pounden, A. L. Trapp,
V. L. Sanger, and D. S. Bell

Departments of Veterinary Science and Animal Science

Vibrionic Abortion: Vibriosis is an infectious disease characterized by abortion of the fetus during the last few weeks of pregnancy. The disease is distributed in all sheep-raising areas of the world.

The causative agent is a bacterium called Vibrio fetus. The main signs of the disease are expulsion of the fetus or a weak lamb that may die shortly after birth. Abortion may occur in 5 to 80 percent of pregnant sheep, depending upon the stage of pregnancy, severity of infection, and immune status of the animals.

The disease can be prevented with the use of a vaccine preparation against Vibrio fetus. Several strains of these organisms are encountered in the field. Vaccination against one particular strain may not protect against an infection with another strain. Preparations containing multiple strains are available commercially.

Vaccination may be recommended in areas where the disease is found. Two doses of the vaccine are given. One is injected 2 weeks prior to breeding and the second is given 4 to 6 weeks later.

In studying the effect of vaccination against vibrionic abortion, it was noted that vaccinated ewes resisted the challenge with live organisms but 40 percent of nonvaccinated yearling ewes aborted. Ewes that aborted in one season were resistant to infection when challenged in the following year. In other words, they appeared to be protected. However, pregnant ewes that lambed normally in one season were susceptible to infection when their immunity was tested in the following season.

This study indicates that when vaccination is recommended, breeding ewes, regardless of age, should be injected before and after breeding.

Lamb Mortality: Infant mortality in lambs may vary from year to year and from one flock to another. This death loss may be attributed to the health status of the breeding flock, the conditions of the lamb, management practices, the genetic behavior of the breeding animals, and other factors.

In detailed studies, the mortality rate was 26 percent of 779 births during th 1965 season. The autopsy findings of 203 lambs dying from birth to 90 days of age or weaning time revealed that 56.6 percent died with pneumonia, 21.6 percent were stillborn, 7.3 percent died from starvation and/or constitutional weakness, 3.9 percent died from white muscle disease, and 8.3 percent died from other conditions such as injury, naval infection, enterotoxemia, or undetermined cause.

Studying the age distribution among lambs that died with pneumonia, it was noticed that 66.4 percent died during the first 10 days, 16 percent between the ages of 11 to 20 days, 8 percent between 21 to 30 days, 2.5 percent between 31 to 40 days, 3.5 percent between 41 to 50 days, 1.8 percent between 51 to 60 days, and 1.8 percent between 61 to 90 days of age.

Pneumonia observed in young lambs was related to their dams. A good correlation existed between the isolation of bacteria from the throats of dams and their lambs and the incidence of lamb pneumonia. The dam may carry these organisms in her throat and transmit them to her lamb by mechanical means such as licking, by airborne infection, or by contact. These organisms in the lamb's throat may invade the tissues of the respiratory tract under certain conditions such as stress and thus may contribute to the production of pneumonia.

The high incidence of infant mortality in lambs during the first few days of life may be attributed mainly to the inability of the dam to raise her lamb. This may be due either to diseased udder conditions or to some part of the multiple birth complex.

To raise healthy lambs, attention should be given to the health status of the breeding flock and proper management procedures.

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